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USSR REPORT

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ERGONOMICS AND DESIGN OF CONTROL SYSTEMS FOR TECHNICAL EQUIPMENT ON SHIPS

ZAKHAROV, G. A.

[Abstract] Design of control systems for technical equipment on ships, now extensively computer-automated, must take into account ergonomic factors associated with the human operator. Such systems, must, therefore, include a man-machine interface. At the same time, ergonomics is not yet adequately developed as a design discipline. There is a need for engineering methods, a data base, and norms necessary for system design and performance evaluation from the standpoint of human involvement and the human link in a control system. Major targets of further development of control systems with this aspect are training new operators for intermittent supervision of engine compartments, overall reduction of supervising personnel, organization of test and inspection procedures, and centralization of automatic control so that, ultimately, fewer persons will play a larger role in running a ship. References: 9 Russian.
[266-2415]

NOISE CONTROL ON SHIPS

MYSHINSKIY, E. L. and SEDAKOV, L. P.

[Abstract] Noise on ships was measured according to All-Union State Standard 12.1.020-79, which covers sound pressure levels in octave bands and equivalent overall sound levels in power rooms, decks and holds, service rooms, public rooms, cabins, and infirmaries. The necessary noise level corrections were determined on the basis of readings taken at definite time intervals and their evaluation. Noise from main and auxiliary diesel engines was still the

most intense and least controlled. Countermeasures included noise suppression at the sources, noise attenuation along the sound propagation paths, and noise suppression in closed and open facilities. Noise at the sources, namely engines and pumps, was suppressed by means of vibration-reducing rotor balancers or dampers. Noise along the sound paths was attenuated by means of screens around the noise sources and flexible inserts of various kinds in ducts and pipes. Noise in open and closed facilities was reduced by means of sound-proofing. Each noise control device was designed for specific frequency ranges, appropriate temperature ranges, and the ambient medium in which it operated. Combining and matching various countermeasures is the most effective and promising approach to noise control. Figures 5; tables 3; References: 13 Russian.
[266-2415]

REQUIREMENTS FOR PUSH-BUTTON CONTROL POSTS OF DECK MECHANISMS

LAPENINA, Ye. V. and KHOZE, V. L.

[Abstract] A major goal in designing energy distribution equipment and mechanisms for ships is to ensure maximum comfort and minimum psychological stress for the crew. This applies to portable equipment including push-button control posts for use on deck. A comparative evaluation was made of the designs of control posts produced by "ASEA" (Sweden), "Stahl" (FRG), "Harnischfeger" (U.S.), "Tomas B. Tryge" (Denmark), and models 1R23, 1R55 produced in the Soviet Union according to All-Union State Standard 14254-80, indicating that the essential design requirements are: manufacturability, compactness, safety, and convenience, also an informative and readable nameplate or panel, with consideration of aesthetics. Figures 6; references: 2 Russian.
[266-2415]

EFFICIENCY OF NOISE SUPPRESSION BY SOUND ISOLATING SHEATHS

STOROZHEV, V. N., DEMYASHEV, A. P. and NOVOSELOV, V. A.

[Abstract] The effectiveness of noise suppression by a sound isolating sheath was evaluated, not on the basis of the conventional relation ($R = -10 \log \tau$ for isolation coefficient R and transmission coefficient τ), but in terms of efficiency $K = -10 \log (I/I_0)$ (I_0 - intensity of sound

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emitted by the source, I - intensity of sound received on the other side of the sheath). Calculations according to the model of a diffuse acoustic field are shown for a double-layer sheath, the most effective sound isolator, with the outer layer of heavy metal serving as sound absorber. The results, confirmed by experimental data, reveal that there can be no sound isolation without sound absorption. With a sound absorbing layer included, the efficiency of sound isolation depends largely on the transmission coefficient and thus also on the reflection coefficient. Figures 1; tables 1; references: 4 Russian.
[256-2415]

OPTIMIZATION OF SHIP'S HULL WITH RESPECT TO REDUCTION OF METAL CONTENT AND ASSEMBLY LABOR

BOYTSOV, G. V.

[Abstract] The cost function was formulated for a ship in such a way that, besides operating, maintenance, and depreciation costs, it includes three explicit terms representing respectively cost of hull metal, cost of hull construction, and overall ship design and construction cost. With a constant sum of these three terms as a design constraint, hull optimization was considered with respect to metal content and assembly labor as minimizable variables. The corresponding algebraic equation of cost effectiveness, normalized to the construction cost and differentiated with respect to the minimizable variables, was solved for those variables as functions of time, load, and safety margin. The resulting relations yield the criteria and the range of optimum hull design. Figures 2; references: 7 Russian.
[266-2415]

NUCLEAR ENERGY

SUBSTANTIATING COMPLEX ION WATER TREATMENT MODES FOR DUAL LOOP NUCLEAR
ELECTRIC POWER STATIONS

MONAKHOV, A. S., candidate of technical sciences, ZVEREV, V. A.,
LUCHKIN, V. G. and SOTNIKOV, A. F., engineers, Moscow Power Engineering
Institute, Novovoronezhskaya Nuclear Electric Power Station

[Abstract] Iron oxide sludge, often along with copper oxide, is always
present in the water AES [nuclear electric power station] steam generators.
The high temperature of the primary loop coolant in such AES piping increases
the concentration of chlorides and alkalis. The increased chloride concen-
tration causes stress corrosion of stainless austenitic steels, while ele-
vated alkali content results in alkali cracking of Inconel-600 type alloys.
The cleanliness of heat exchanger surfaces is restored by changing from
phosphating of boiler water to the complex ion treatment of the feedwater,
which can scrub the system during operation, using dosages substantially
exceeding the stoichiometric quantity needed on the basis of the feedwater
composition. Continuous comprehensive ion water treatment will prevent the
formation of sludge and its deposits on critical moderate pressure boiler
and steam generator surfaces. Care is required since experience shows that
a single break can occur with seemingly insignificant overall deposits while
fully meeting the water condition norms. Even with practically clean heat
exchange surfaces, local sludge deposits are still possible. The undisputed
advantages of ongoing ion water treatment for water-moderated water-cooled
power reactors are best realized if each steam generator is provided with
its own dosing pump for feeding the treatment solution from a tank common
to the entire system. Continuous treatment of this type does not preclude
the necessity of correcting the condensate with hydrazine or oxygen (depend-
ing on whether brass or steel low pressure heaters are used).
References 14: 13 Russian; 1 Western.
[170-8225]

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NON-NUCLEAR ENERGY

RECUPERATIVE CONTROL OF THERMAL ELECTRIC POWER STATION FEED PUMPS

TURKIN, A. N., candidate of technical sciences and RUZHKOVSKIY, B. G.,
engineer, Urals Branch of the All-Union Order of the Red Banner of Labor
Thermal Power Engineering Institute imeni F. E. Dzerzhinskiy (Chelyabinsk)

[Abstract]   Since up to 50% of the in-house power consumption of TES's is
used by turbine feed pumps, it is important to look at efficient means of
controlling the speed of such multistage pumps in order to boost overall
station efficiency. The Urals Branch of the All-Union Order of the Red
Banner of Labor Thermal Power Engineering Institute has designed a hydraulic
control system for these pumps, which uses rotating vanes, installed follow-
ing the diffusor of one of the intermediate stages, and a turbine wheel
mounted on the shaft ahead of the rotor of the next pumping stage. This
configuration allows the return of fluid energy at the pump shaft directly
to the turbine wheel and the efficient use of the fluid circulation at the
outlet from the turbine wheel in the subsequent pump stage. The vanes are
rotated by a shaft coupled to the pump control mechanism through a gear
train, consisting of a driving conical gear, an intermediate gearing with
double-sided engagement of the gear teeth and satellite gears mounted on
the blade shafts. This recuperative retrofit was accomplished by installing
the new hardware in place of one of the removed pump stages, thus retaining
the shaft and major components during the rebuild. The impact of this sys-
tem on station performance was initially studied at the Serovskaya GRES in
1976. This experience led to refinements in the system which were imple-
mented at Verkhne-Tagil'skaya GRES in 1982. Recuperative control of single
housing feed pumps at a working steam pressure of 9 MPa with the simultaneous
operation of 2 to 2 controlled pumps and several uncontrolled pumps reduces
the pressure in the main feed boilers, improves the reliability of the con-
trolled feed channels and saves power for the pump drives. The payback
period for the capital investments in pump retrofitting is no more than
2 years. Work is now underway on a recuperative control system for the
double-housing feed pumps of TES's at a steam pressure of 13 MPa. It is
recommended that such systems be used on a wide scale. Figures 5;
references: 4 Russian.
[170-8225]

5

DETERMINATION OF OPTIMAL CIRCULATION WATER FLOW RATE IN 800 MW POWER UNIT

ZUSMANOVICH, L. B. and FEDOROV, V. I., engineers, Donets Power Engineering Administration

[Abstract] The maintenance of an economically efficient vacuum in turbine condensers reduces to the maintenance of the optimal cooling water flow rate, W_{opt}, through the condensers. This paper details test data on the requisite characteristics for the calculation of W_{opt}; the tests were conducted by the Donets Power Engineering Administration on an 800 MW power unit (No. 5) of the Uglegorskaya GRES. Cooling water is delivered by two OPV 10-185EG circulation pumps via 2,400 mm diameter pipes 200 m long to a single pass, dual flow condenser. The hydraulic resistance of the circulation system and its individual sections as well as the power required by the pumps are plotted as a function of the rate of flow. Values of W_{opt} are summarized in tabular form for various operational parameters of the K-800-240-3 turbine set. W_{opt} varies depending on the operating conditions from 59,000 to 97,500 m^3/hr. A precise determination requires the use of the actual condenser and circulation system parameters in any analysis. Optimization of such system operation at electric power stations requires improvement of the operational reliability of the mechanisms for rotating the vanes of the circulation pumps. Figures 5; tables 1; no references. [170-8225]

STUDY OF START-UP THERMAL STATUS OF MEDIUM PRESSURE ROTOR OF K-200-130 TURBINE OF THE LENINGRAD METAL PLANT

LEVIT, I. G., FURMAN, R. M., engineers, and AVRUTSKIY, G. D., candidate of technical sciences, Khar'kov Branch of Glavenergoremont Central Design Office, All-Union Thermal Power Engineering Institute imeni F. E. Dzerhinskiy

[Abstract] A K-200-130 turbine was tested in four start-up modes: 1) From the hot state after a downtime of 6 to 10 hours; 2) From a warm state after 30 to 40 hours down; 3) From a warm state after 50 to 60 hours down, and 4) From the cold state after being shut down for more than 96 hours. Since the medium pressure rotor of this turbine is the major component limiting its load handling response and flexibility, data were obtained on the thermal conditions of the rotor for the above conditions in order to: 1) Determine the temperature field of the medium pressure rotor when operated in line with standard instructions for start and shutdown of a 200 MW power

unit with a TP-100 drum boiler; 2) Ascertain starting conditions which are the most unfavorable from the standpoint of the appearance of maximum temperature gradients over the rotor radius; 3) Analyze the impact of preheating the rotor on its thermal status and compare the rotor status for non-preheat starts with various combinations of sources of the packing and heating steam. The maximum temperature differences over the rotor radius are summarized in a detailed table for the four starting modes and curves of the temperature rise for these four cases are plotted as a function of time. The maximum temperature differences over the rotor radius in all modes occur in the region of the front end packing and diaphragm packings of stage 14. In the case of starts with preheating of rotor, the maximum temperature differences are observed in the initial start-up period prior to the turbine rotation. Preheating reduces these differences by 50 to 80°C in the area of the front end packing when the load is set at 60 to 150 MW. In the case of preheat starts, it is permissible to supply packing steam from 0.6 MPa deaerators at a temperature of 110°C during the entire start (instead of steam from a backup source at 210 to 240°C). Any analysis of the medium pressure rotor temperature field in the region of the forward end packings must take into account the influence of heat exchange between the steam and the rotor metal on the temperature of the flowing steam. Tables 2; figures 5; references: 3 Russian.
[170-8225]

SPECIFIC FEATURES OF AUTOMATION OF PRODUCTION PROCESS OPERATIONS IN MACHINE
BUILDING USING AUTOMATIC REMOTE CONTROLLED INDUSTRIAL ROBOTS

PODURAYEV, Yu. V., engineer

[Abstract] Automated remote controlled industrial robot systems which pro-
vide for operator participation in the control process make it possible to:
1) Use robots for complex production operations typical of mass production
where the percentage of manual labor is particularly high at the present
time; 2) Expand the functional capabilities of existing robots without using
complicated adaptation hardware; 3) Curtail the remote teaching time of an
industrial robot as compared to present times using existing control con-
soles; 4) Establish automatic remote control with remote correction of the
degrees of robot mobility, which will permit a significant reduction in the
requirements placed on precision of the actuating element of a robot and
the production hardware. Two robot control configurations are illustrated
with block diagrams and discussed: 1) Direct computer control of the robot;
2) Automated remote control using a microcomputer with a human operator in
the feedback loop between the robot and the programmer, providing for opera-
tor corrections of the control sequences. The latter scheme is viewed as
more promising and flexible, permitting the use of simple and less expensive
robots. The appearance of Soviet made UKM automatic control systems will
allow the hardware and control algorithm interfacing of remote and automatic
control systems using the microcomputers incorporated in them and thereby
most effectively utilize the capabilities of automatically remote controlled
industrial robots. Figures 2; references: 3 Russian.
[194-8225]

INFLUENCE OF ANTICORROSION ADDITIVE ON PERFORMANCE OF A FRICTION PAIR IN
INCOMBUSTIBLE HYDRAULIC FLUID

TOLOKONNIKOV, V. I., BERDENIKOV, A. I., engineers, and RYBAKOVA, L. A.
doctor of technical sciences

[Abstract] The use of hydraulic drives in explosion and fire hazardous en-
vironments has stimulated the production of synthetic incombustible hy-
draulic fluids ("Promgidrol") in the USSR. These contain from 30 to 50%
water, glycerin and a water-soluble thickening agent. The performance of
friction pairs is degraded when this material is substituted for mineral
oils in hydraulic drives. This paper presents data from a comprehensive
study of the effect of the anticorrosion additive benzotriazole in these
incombustible hydraulic fluids on the wear resistance of a friction pair
consisting of BrAMts9-2 bronze and tempered steel 45, widely used in hy-
draulic systems. Type P20M2 synthetic fluid containing from 0 to 0.5%
benzotriazole was tested in these friction pairs at an average slip rate of
0.1 m/sec and a load of 10 MPa. The surface layers of the aluminum bronze
were studied by x-ray diffraction analysis, which demonstrated that reducing
the benzotriazole content in the fluid down to levels on the order of 0.2%
for copper alloy--steel friction pairs provides quite adequate protection
against corrosion and good wear immunity. The requisite service life of
machinery using water and glycerine hydraulic fluids requires an accurate
determination of the additive content, in particular, benzotriazole content
in type P20M1 and P20M2 hydraulic fluids. Figures 1; tables 1; references:
6 Russian.
[194-8225]

MANIPULATOR FOR LOADING AND UNLOADING OPERATIONS ON AN OVERHEAD CONVEYOR

MOLCHANOV, V. V. and ONISHCHENKO, B. K., engineers

[Abstract] Since loading and unloading operations with an overhead conveyor
requires considerable labor expenditures, this paper proposes a manipulator
for the mechanization of these operations, thereby increasing the efficiency
of an in-house transport system. The manipulator is designed to pick up
groups of castings from the shake-out grid of a Kunckel-Wagner pouring and
molding line and then hang them on an overhead KT-160 push type conveyor.
The operator visually monitors the engagement process and has manual control
from a console over the drive mechanisms of the manipulator carrier, the

hoisting of the load and rotation of the load support column as well as the load grasping mechanism. After a group of castings is grasped by the hooks of the load latching platform, the operator raises it above the shake-out grid, makes sure that the load is securely grasped and switches the manipulator over to automatic operation. The automation is designed for failure-free service for 10 years under foundry conditions. It permits stopping the manipulator carrier with a precision of ± 15 mm, and an angular error in setting the rotating platform relative to the hanging hooks of the conveyor of no more than 30' in each direction. This orientation accuracy is achieved by both electrical and electromechanical means which duplicate each other. One operator can service two manipulators simultaneously. The initial configuration and position of the manipulator prior to hanging a product on the overhead conveyor are illustrated with three drawings. The introduction of the manipulators at one railroad car construction plant will make it possible to gain an economic savings of 44,700 rubles per unit. Figures 3.
[194-8225]

UDC 621.822.5

DETERMINATION OF PERMISSIBLE LOAD ON A SLIP BEARING BASED ON ULTIMATE STRESSED STATE OF THE ANTIFRICTION MATERIAL

Moscow VESTNIK MASHINOSTROYENIYA in Russian No 2, Feb 84 pp 37-39

TODER, I. A., candidate of technical sciences

[Abstract] The permissible load on a fluid friction bearing can be determined from the ultimate stressed state of the bearing material. The absence of plastic deformation of the antifriction bearing material is used as the criterion defining this state, since it is necessary to maintain a constant bearing geometry in the case of fluid friction. The melting of soft antifriction materials is also prevented then as they heat up during operation. This paper studies a bimetal bushing with an antifriction facing subjected to stress from the applied load, the temperature, the bending of the bushings which are mounted in a carrier housing with a gap between them. The analysis demonstrates two possible three-dimensional stressed states of the antifriction material: 1) The temperature stresses of the antifriction coating are tensile stresses; 2) These stresses are compression stresses and add to the applied load stresses. The maximum load on a fluid friction bearing is calculated for the sample case of a bearing with a diameter of 180 mm with a babbitt B83 facing 3 mm thick running at a rolling speed of 50 m/sec; the temperature rises from 70° to 100°C. The radius of curvature of the bushing is an ellipse, with the resulting stresses from this also considered. The maximum load is found to be 5.3 MPa. Better antifriction materials than babbitt metal must be used in high speed rollers, i.e., lead-bronze in conjunction with a lead-tin run-in facing such as used by the Morgan company in the U.S. for rolling speeds up to 90 m/sec. The permissible specific loading is about 50 MPa in this case. Figures 2; references: 6 Russian.
[194-8825]

SPECIFIC FEATURES OF PLANETARY DRIVE CONFIGURATIONS FOR FLEX-RING GEARING

IVASHOV, Ye. N. and NEKRASOV, M. I., candidates of technical sciences

[Abstract] Planetary assemblies for flexible ring gears occupy a special
place among the diverse structural designs of mechanical flex generators
for such gearing, which is due to their fixed transmission ratio. A plane-
tary drive for a flex gear ring consists of a massive internal ring which
is nondeformable and an outer deformable ring, both rings having races for
ball bearings. The carrier bearing balls produce the requisite deformation
of the outer ring and the support bearing balls maintain a constant deforma-
tion under load, which aids in increasing the load capacity of a gear and
its service life. This paper derives equations describing the deformation
of the outer gear ring and the positioning bearing balls in three types of
planetary driven flex-ring gears: 1) Forced deformation; 2) Semiforced de-
formation (using support bearing balls) and 3) Free deformation of the outer
ring using two, three and four drive balls. The adduced formulas define
the gear ratio assuming no slip in the planetary drive, since experiments
show that slip has no marked influence on the gear ratio or kinematic pre-
cision of such flex ring gearing. The use of these gears is best for
lightly loaded systems (output moment of less than 50 N·mm). The dimensions
of six flex-ring gears proposed for mass production are summarized in a
table. Figures 4; tables 1; references: 8 Russian.
[194-8225]

PROBLEMS IN DESIGNING FLEXIBLE AUTOMATED PRODUCTION SYSTEMS

VOYCHINSKIY, A. M.

[Abstract] Flexible automated production systems with extensive use of in-
dustrial robots and automatic manipulators must be based on optimal planning
and proper technological preparation. A thorough analysis and classifica-
tion of product, labor and tooling are required for the design of such a
system. This applies typically to casting, stamping, machining, plastics
reprocessing, painting, galvanizing, and machine assembly operations. Suc-
cessive specialization-mechanization-automation of a machine room, for in-
stance, will ultimately eliminate 95% of all manual labor. The most impor-
tant design criterion and performance indicator of flexible automated
production systems is, accordingly, the relative weighted labor force.

In a modular system each operational unit is flexibly automated, with a production planning station and a foreman control station aided by micro-computers (Electronika-60) and communication links. Development engineering and manufacturing engineering departments are centralized, aided by a large computer (YeS-1033 Unified System) and minicomputers (SM-4). Figures 3; tables 1; references: 2 Russian.
[266-2415]

AUTOMATION--IMPORTANT TREND IN DEVELOPMENT OF COMPLEX MAN-MACHINE SYSTEMS

ZAKHAROV, G. A. and PADERNO, P. I.

[Abstract] A conference on "Automation of Scientific Research, Ergonomic Design and Testing of Complex Man-Machine Systems" was held on 26-28 April 1983 in Leningrad by the USSR and RSFSR Ministries of Higher Education and the Leningrad Regional Science-Engineering Council. The major topics covered in presentations and discussions were humanization of labor in an automated national economy, size and qualifications of control systems personnel, con-struction of algorithms and algorithmization of activities, and organization of workshops and control rooms. The major tasks ahead were found to be refin-ing the terminology of such systems with greater emphasis on human factors, developing methods of forming desired or required ergonomic figures, devel-oping methods of solving problems in ergonomic design and product quality control, and developing methods of estimating the effects of ergonomic de-sign. Proceeding with these tasks will require practically feasible methods of stochastic programming, reduction of the dimensionality of optimization problems for computer-aided solution, methods of solving multicriterial prob-lems by trade-off, mathematical programming, and dialog procedures, also use of proportional scales in linear programming, solution of practical optimiza-tion problems in ergonomic design of complex hierarchical man-machine systems, universal-system software for automated ergonomic design, application pro-grams, and programming the data output. First priority must be given to development of approaches to formalization of ergonomic knowledge and data, acquisition, generalization, and unified presentation of ergonomic knowledge and data for building an ergonomic data bank usable by computers, and devel-opment of an appropriate language.
[266-2415]

DESIGNING THE PROFILE OF TURBINE BLADES USING AN ITERATION TECHNIQUE

SOKOLOVSKIY, G. A. and VANIN, V. A., Institute of Problems of Machine Building, UkSSR Academy of Sciences, Khar'kov

[Abstract] Partial integro-differential equations describing the gas flow in a plane turbine cascade are solved to determine the blading profile which provides a pressure distribution close to a specified form when an ideal gas flows through the stage. The set pressure distribution over the profile contour should satisfy the conditions of the most advantageous flow from the standpoint of energy losses. The maximum pressure difference between the concave and convex sides must be generated in order to provide the greatest lift force. Since a large number of profiles can meet this condition, the choice of the pressure distribution is made on the basis of the experience of the designer. The quantities specified at the inlet cross-section are the pressure of the retarded flow, the braking temperature and the direction of the velocity; the quantity specified for the output cross-section is the static pressure. An algorithm is written in ALGOL-GDR for the BESM-6 computer which has been approved for the study of subsonic and transonic vane blading profiles. The algorithm starts with an initial approximation and then establishes the optimal configuration through a short series of iterations by changing the shape of just the convex surface. This approach to cascade theory allows the design of aerodynamically sophisticated profiles with preset properties. Figures 2; references: 8 Russian.
[174-8225]

CALCULATING SECONDARY NONVISCOUS GAS FLOWS IN SPATIAL CASCADES OF TURBINES

GNESIN, V. I. and SOLODOV, V. G., Institute of Problems of Machine Building,
UkSSR Academy of Sciences, Khar'kov

[Abstract] The flow of an ideal gas in the stationary channels of turbine
machines in the presence of an overall pressure gradient in the channel
cross-section is accompanied by secondary flows, which must be considered
when optimizing the efficiency of the blading. This paper is a numerical
study of the flow through a ring cascade which consists of the blading
of a high pressure nozzle stage. The vorticity of the flow is specified
in terms of the total pressure distribution at the input to the region
being analyzed. The spatial flows modeled in this way are compared
with a set of two-dimensional flows at the axially symmetric surfaces
of rotation (the main flow) for various total flow pressures and tempera-
tures. The spatial flow of the gas is treated as the superposition
of this main flow and the secondary flow which appears at surfaces
with current lines orthogonal to the main flow. The secondary flow
can be treated as a two-dimensional vortex motion of a fluid. A specific
feature of this approach is the capability of ascertaining the radial
overflows which occur in the spatial flow. The total pressure in this
numerical example is assumed to have a parabolic distribution with
a maximum of 117 KPa and a minimum of 100 KPa; the temperature is 315 K
and the flow entrance angle is 90°. The structure of the secondary
flow is illustrated in different channel cross-sections by showing
the projections of the vectors for the difference between the velocity
vectors of the vortex and main flows on the planes of sections orthogonal
with the channel axis. The proposed model for the development of secondary
flows is valid when studying the spatial structure of real flows in
blading rings with long blades and a sharp opening flare of the boundary
surfaces. The analysis is of interest for the study of the impact
of secondary flows on the process of boundary layer swelling and convolution,
which stimulates the phenomenon of boundary layer separation. Figures 2;
references 11: 5 Russian; 3 Western, 3 Western in Russian translation.
[174-8225]

DETERMINATION OF TOTAL PRESSURE LOSSES IN STEPPED ANNULAR DIFFUSORS WITH
CURVILINEAR OUTER WALLS AND UNIFORM VELOCITY FIELD AT INLET

DANTSYG, A. Ya. and PETROV, N. M.

[Abstract] The influence of the shape of the generatrix of the exterior
wall of a diffusor is studied for five outer wall configurations with gen-
eratrices in the form of two circular arcs, run tangentially to the inlet
and outlet cylindrical sections. The variable geometric parameter
for the study is the relative axial coordinate of the point of inflection
of the curve in the outer wall. The coefficients of shock attenuation
which characterize the total pressure losses in such diffusors with
a uniform velocity field at the input are plotted as a function of
the geometric variable and the normalized inlet velocity. The method
of least squares is applied to the data in order to derive an analytical
formula for the losses, which is written as a third order polynomial.
As the inlet flow velocity increases, diffusors with curvilinear outer
walls ultimately have 25% lower losses than the same diffusor with
a straight wall. When the curvature point of inflection is a particular
distance beyond the diffusor outlet, the curvilinear outer walls provide
no advantage over their straight counterparts. The boundary conditions
for the use of the derived approximations for the losses are specified
and the coefficients of the expressions are listed in two tables. Figures 5;
tables 3; references: 3 Russian.
[165-8225]

INFLUENCE OF NORMALIZED FREQUENCY ON TIME-DEPENDENT AERODYNAMIC CHARACTERIS-
TICS OF VANE BLADING PROFILES

GNESIN, V. I. and YERSHOV, S. V., Institute of Problems of Machine Building,
UkSSR Academy of Sciences, Khar'kov

[Abstract] Time-dependent flow through mutually moving vane blading pro-
files is characterized by the frequency $k = fz_1b/2V$, where f is the angular
velocity of the rotor, z_1 is the number of blades of the fixed cascade, b is
the working blade chord and V is the relative flow velocity. Different nor-
malized frequencies can be obtained by changing the angular velocity fz_1 of
the step nonuniformity wave along the cascade front in the gap between the

guides and the rotor; $fz_1 = 0$ applies to the quasisteady-state flow hypothe-
sis. This paper proposes a method of specifying the normalized frequency,
which ascertains its impact on the time-dependent parameters of the vane
blading while observing Mach number similitude and geometric similitude. A
complete system of time-dependent equations of gas dynamics and the explicit
finite difference scheme of S. K. Godunov is applied to the case of two
mutually moving cascades with the following characteristics in a normalized
frequency range of k = 0 to 6: $z_1 = 66$, z_2 for the working cascade (rotor) =
110, relative nozzle cascade step is $t_1/b_1 = 0.49$, that of the rotor is
$t_2b_2 = 0.57$, the rotor speed is 157 rad/sec and the ratio of the static pres-
sure per stage to the total pressure is $p_2/p_0 = 0.16$. It is found that the
quasisteady-state flow hypothesis is applicable only to small normalized
frequencies of k less than 0.5. When k is greater than 0.5, the quasisteady-
state solution overstates the amplitudes of the time-dependent force pulsa-
tions and understates the amplitudes of the moment pulsations. The error in
this case can range from 30 to 500%. When k = 1.88, this is an error of
about 400% with respect to the moment amplitude and 70% for the time-dependent
peripheral force. Figures 4; references 4 Russian.
[174-8225]

INFLUENCE OF SECONDARY FLOW RATE ON DYNAMIC STRESSES IN TURBINE ROTOR BLADES

SHEKUN, G. D., candidate of technical sciences, Komsomol'skiy-na-Amure
Polytechnical Institute

[Abstract] A drawback to previous methods of estimating the dynamic stresses
during turbine rotor blade vibration, which are based on studies of the de-
gree of flow velocity nonuniformity in the gap between blading rings, is the
lack of data on the extent of flow nonuniformity parameters in the
end regions. Flow nonuniformity in the end regions of nozzle system
channels due to secondary flows was determined in an earlier paper
by the author by modeling the peripheral cross-section of a nozzle
system with a blade length of 90 mm, chord of 116 mm, step of 114 mm
and a flow outlet angle of 26°54'. The velocity fields and static
pressures were found at the inlet to the blading and behind the outlet
edges in these studies, which demonstrated the possibility of reducing the
rotor blade vibration by structurally interfering with the secondary
flows in these end regions. This paper continues the experimental study
of the vibrational stress in this case. The dynamic stresses from bending
and torsional oscillations of the rotor blades are determined at the
fundamental frequency of the resonant bending oscillations; the qualitative
picture of the impact of secondary flow rates in the end regions on
the dynamic stresses is discussed. The experimental configuration for
the strain gauge measurements is illustrated. The secondary flows are

controlled by means of additional vanes which are inserted between the
rotor blades to reduce the level of stress both at the tip and root
of the blades. The dimensions of added vane for optimal stress reduction
are given. The measured dynamic stresses at the blade roots are shown
to be the total bending and torsional oscillation stresses of the rotor
blades. Figures 4; references: 2 Russian.
[170-8225]

ON ONE DESIGN PRINCIPLE OF SURGE PROTECTOR FOR GAS TURBINE ENGINE COMPRESSOR

SHAKIR'YANOV, M. M.

[Abstract] Gas dynamic instability in the compressors of gas turbine en-
gines, i.e., surging, can cause the failure of the compressor and the entire
engine. Existing surge elimination methods are based on the use of a priori
data on changes in the gas-air parameters. An earlier approach to determin-
ing the conditions for surging is based on a criterion which relates
the acoustic mass L_a of the intake pipe and the acoustic elasticity
of the air volume C_a; the use of such a parameter is difficult because
it is impossible to measure these quantities directly. This paper describes
the design of a surge detection and correction system based on the parameter
L_a/kC_a (k is a throttling resistance coefficient characterizing the
flow carrying capacity of the gas-air channel) using the direct air
flow parameters. L_a is expressed in terms of the length and cross-
section of the intake pipe and the air density in the pipe; C_a is in
terms of the air density and volume and the speed of sound following
the delivery pipe. A specific algorithm is derived which describes
the gas dynamic state of the engine and a block diagram of an antisurging
system is drawn. The proposed protector detects surging quickly with
a sharp change in the temperature or pressure at the engine intake.
When surge oscillations are due to other factors, the pressure increase
following the compressor changes, which also actuates the protector.
The algorithm derived here allows the design of surge protection systems
with a fast response and considerable information content. Figures 3;
references: 2 Russian.
[165-8225]

ON SELECTING BYPASS MIXERS FOR TURBOFAN ENGINES

FISHBEYN, B. D.

[Abstract] The performance of turbofan engines can be enhanced by boosting
the bypass ratio up to 6.5 to 7.0 in bypass mixing systems. Only the optimal
fractions of the primary and bypass flow masses are to be incorporated in
the mixing process in this case. With ideal mixing, the maximum thrust
increase corresponds to bypass/primary mass rates of flow of 1.0, however,
actual energy losses limit these values to different optimal levels.
A factor taking into account the energy losses of the mixed streams
is adduced and used in writing an expression for the relative change
in the output impulse. Equations are then derived for the best case
bypass ratio and curves are plotted using an M-222 computer to determine
the isodynamic lines for turbofan engines with bypass ratios of between
0.5 and 8.0 for various increases in the output impulse. When the bypass
ratio is greater than 2.0, the maximum possible relative rise in the
output impulse falls off continually and is approximately 220% lower
when the ratio is 8 than when it is 2.0. However, because of the increase
in the thrust gain (the percentage change in the engine thrust per 1%
change in the output impulse) with the increase in the bypass ratio,
the relative gain in the thrust is nearly constant. Turbofan engines
with high bypass ratios of 4 to 8 can achieve the maximum thrust increase
by means of an efficient mixer which incorporates approximately 30 to 60%
bypass air in the mixing process (and 20 to 50% in the case of elevated
energy losses) and approximately 80 to 100% of the gas from the primary
circuit. Figures 4; references 5: 2 Russian; 3 Western.
[165-8225]

INFLUENCE OF SETTING ANGLE OF JET COOLING NOZZLES ON TEMPERATURE AND STRESS
STATE OF A TURBINE WHEEL

ZHUYKOV, V. V., LASHUK, Ye. I. and YUNKEROV, Yu. I.

[Abstract] Turbine wheels in gas turbine engines are cooled by coolant jets
directed onto the disk surface. The setting angle of the jet nozzles has
an impact on the heat transfer coefficients in the blasted region of the
wheel. This paper is a numerical analysis of the temperature and stress

state of the turbine wheel of a full scale, but small gas turbine engine.
A simplified schematic of the wheel cooling system is drawn and the boun-
dary conditions for heat exchange at the lateral surfaces are depicted
graphically for the front and back of a wheel. The temperature distribu-
tion over the center line of the meridianal section of a wheel is plotted
for nozzle setting angles of 60° and 90°, the latter being the most
wide spread. The mounting of the nozzles at the optimum angle with
respect to the end face surface reduces the average disk temperature
by more than 30°K (about 6%). The temperature gradient between the
wheel rim and bearing also is reduced by more than 20%. Setting the
nozzles at an angle of 60° increases the disk strength reserve by up
to 5% in the region of maximum stresses and up 5.3% in the nozzle mounting
area. The distribution of the radial and tangential stresses, as well
as the strength safety margin of the wheels are also plotted over the
section line of the wheels for the two setting angles of 60° and 90°.
Failure to consider nozzle angles when determining heat transfer coefficients
in the cooling blast region can lead to considerable errors when calculating
the temperature and stress states of such turbine wheels. Figures 3;
references: 17 Russian.
[165-8225]

IMPROVEMENT OF GAS TURBINE ENGINE PERFORMANCE BY WATER INJECTION INTO
TURBINE COOLING AIR

GORELOV, G. M., DANIL'CHENKO, V. P. and REZNIK, V. Ye.

[Abstract] The temperature of the air cooling a turbine can be reduced by
spraying some water into a special heat exchanger inserted in the bypass
loop of a ducted fan high-temperature gas turbine engine. This paper com-
pares the temperature reductions of various engine cooling techniques, using
the specific fuel consumption of the engine as the governing criterion,
which is not a purely thermodynamic indicator, but also takes into account
the impact of the variable and fixed masses of the cooling system on the
on-board fuel reserves of an aircraft during take-off. The air-cooling sys-
tem is shown with a schematic drawing, indicating the distilled water tank,
feed pump, turbine drive and distribution header with the injector nozzles.
The equivalent fuel consumptions are compared for the case of pure air
cooling, air with a decreased air rate of flow set for the flight cruising
mode and water injection for take-off as well as air cooling via a heat
exchanger. Even with moderate cooling of the turbine blades, injection
of water into the cooling system permits a considerable reduction in
the specific fuel consumption. When a heat exchanger is used instead
of water, the specific fuel consumption under crusing conditions rises

substantially because of hydraulic losses and is 0.6 kg/kgf·hr, i.e.,
no advantage is gained from boosting engine operating parameters. This
is obviously why numerous foreign companies are working on the introduction
of water injection systems in order to increase the service life, reliabil-
ity, expand the operating range and the capabilities of the basic engine.
Figures 4; references 5: 4 Russian; 1 Western in Russian translation.
[165-8225]

EXPERIMENTAL STUDY OF AERODYNAMIC SHIELDING OF TURBOJET ENGINE AIR INTAKE
AGAINST EXHAUST GASES

VYSOKOGORETS, M. M., GILYAZOV, M. Sh., KOSTERIN, V. A. and KHABIBULLIN, M. G.

[Abstract] The widespread use of engine reversers in turbojets requires pro-
tection of the turbine compressor system against the entry of high tempera-
ture reverse jet gases into the intake. Aerodynamic shields are one of the
most promising approaches to this. This paper summarizes an experimental
study of aerodynamic shielding by means of a single circular stream,
blasted into the air intake plane of symmetry at an angle of 90° relative
to the aircraft runway surface. The data were obtained using a cylindrical
model of a turbojet air intake positioned 50 mm above the shield simulator
of the airstrip. The engine simulating aerodynamic tube was 300 mm
in diameter; the edges of the intake had an outside diameter of 50 mm
and an inside diameter of 26 mm, and were rounded off to assure nonseparating
flow. The temperature fields close to the edge of the air intake in
its plane of symmetry at a distance of 1 mm from the edge were recorded for
various protective air flow rates. The data permit the determination of
the temperature drop at the air intake edge. Figures 5; references:
1 Russian.
[165-8225]

EXPERIMENTAL STUDY OF INFLUENCE OF SIZE OF UPPER AND LOWER LAPS ON OPERA-
TIONAL EFFICIENCY OF CENTRIPETAL FULL-INLET AIR DRIVEN MICROTURBINES

TIKHONOV, N. P., TIKHONOV, A. N. and GRACHEVA, S. M.

[Abstract] Lap is the term for the difference in the heights of the rotor
blades and the nozzle set in a turbine. The overall lap is composed of the
upper lap (at the blade periphery) and the lower lap (at the blade root).
Since there is intense meridianal deformation of the flowing material
stream at the outlet from a microturbine nozzle set, a lap is necessary
for the entire stream to impinge on the working blades. Both insufficient
and excessive upper and lower laps degrade stage efficiency, thus necessi-
tating optimization of the lap values. This paper summarizes data from
an experimental optimization of a stage with an unbanded rotor having
outside diameter of 49.5 mm with a nozzle set blade height of 1.25 mm.
The studies were made at rotational speeds of from 130 to 1,000 Hz with
expansion factors of 2, 3, 4, 5 and 6. Optimization makes it possible
to boost the efficiency by 6 to 20%. It was found that the optimal
laps are independent of the size of the radial gap. The experimental
data have been for microturbines with outside rotor diameters of from
25 to 80 mm and nozzle set blade heights of from 1 to 3 mm. The difference
between the calculated and measured increase in the efficiency does
not exceed 3%. Figures 4; references 4: 3 Russian; 1 Western in Russian
translation.
[165-8225]

CALCULATING HEAT TRANSFER COEFFICIENTS FOR TURBINE PROFILES TAKING SURFACE
CURVATURE AND ELEVATED FLOW TURBULENCE INTO ACCOUNT

SOVERSHENNYY, V. D. and CHIKOVA, S. P.

[Abstract] Partial differential equations describing the heat transfer to
a transpired turbulent boundary layer are solved by numerical integration.
It is assumed that regions of laminar, turbulent and transitional flow can
exist simultaneously in the boundary layer. The solution of this closed
system of heat transfer equations is illustrated with the calculation of
the heat transfer to a turbine profile for two degrees of incident flow
turbulence: 0.45% and 5.9%. The good agreement between the computed and

experimental heat transfer data is illustrated with a graph showing the heat
transfer as a function of the position of various points on the turbine pro-
file. Extended regions of laminar flow are observed with a low level of
turbulence. When the turbulence increases, a transient flow mode predomin-
ates (the transfer coefficients have values between the molecular and molar
levels) and the heat exchange increases significantly. A similar graph is
drawn for the case when surface curvature is disregarded, demonstrating
that considering such curvature is important in transition and turbulent
regions and markedly improves the conformity of theory to experiment (especi-
ally on the concave side of the turbine profile). Figures 3; references 11:
8 Russian; 3 Western.
[165-8225]

CORRECTION OF ENGRAVING STAMP FOR FORMING BLANKS OF GAS TURBINE ENGINE BLADES

ZYKOV, V. Yu., PAVLOV, A. F., KAZAKOVA, L. T. and YUNUSOV, F. S.

[Abstract] High precision blanks without any machining allowance or with a
blade allowance of 0.3 to 0.5 mm, depending on the blade size, are used for
blade production for gas turbine engines in order to reduce the labor require-
ments of the machining and improve the material utilization factor. Studies
of blanks produced by stamping show that residual stresses from stamping
are responsible for the deformation of the stamped blade leading to both
a linear displacement and angular rotation of the blade shape from its nominal
position. The blade blanks of large gas turbines sometimes show spatial de-
viations of the shape exceeding the allowance for the subsequent machining
and finishing operations. This paper proposes a procedure along with the
control computer algorithm for producing a corrected stamp engraving which
eliminates the influence of blank deformation due to residual stresses.
The computer program is written in FORTRAN-IV for the unified series compu-
ters. The spatial deviations of blank profiles are reduced to levels limited
by the design drawings. The number of reference sections and points in these
blade sections at which the corrections are made can run up to 30. When
necessary, the volume of raw data can be increased by means of replacing the
dimensionality operator in the program. Tables 2; references: 4 Russian.
[165-8225]

SPEED GOVERNOR FOR DIESEL ENGINE

KADYSHEVICH, Ye. Kh., MISELEV, M. A. and SVISTUNOV, N. N.

[Abstract] A speed governor was developed for the 12ChSN 18/20 ship diesel engine for the purpose of reducing emission of fumes and eliminating transient overloads, with pneumatic correction of the fuel injection rate according to the supercharge pressure. In addition to the electric tachometer and the pneumatic corrector, the device includes a hydraulic amplifier with slide valve. The tachometer is started and the amplifier valve is moved out by a spring which closes the normally open contacts in the tachometer circuit while pushing the valve stem. The regulator was tested in fast acceleration of the diesel engine from reversal level (184 kW - 800 rpm) to full load (625 kW - 1550 rpm) by turning the crank, to which the spring is attached at its other end, with a time of 1 s. The regulator was found to improve the performance, including torque and combustion characteristics. It reduced the emission level to 15% within 2 s and finally decreased only to a 65% level. It was also tested on a "Kometa" hydrofoil ship with regulation of the diesel start over an 80-90 s acceleration period independently of the crank turning time, and was found to maintain overloads and fume emission within prescribed limits. Figures 3.
[266-2415]

USE OF BRAKING STAGES FOR CONTROL OF TURBINE SPEED

POGODIN, Yu. M., TOPUNOV, A. M. and CHERNOV, A. I.

[Abstract] The external characteristics of small turbines on ships can be varied through reduction of the limiting specific speed. The object is to obtain a steep efficiency-speed curve asymmetric with respect to the maximum-efficiency point. Theoretically this should be attainable by design of the turbine passages, but practically it is not posible to cover all modes of operation in this way. The possibility of attaining this by means of special device "cutting into" the operation as required has been proposed, and such a device was developed at the Leningrad Institute of Shipbuilding. It is essentially a brake inserted into the diaphragm of an intermediate guide stage between two runner stages. It consists of two adjoining ring segments, a shorter one which carries vanes oriented

relative to the nozzle for maximum efficiency in the base mode of operation, and another approximately 40% longer which carries vanes with their concave side in the direction of rotation for braking. The theoretical principle was tested experimentally with two such braking stages in a turbine operating at two speed levels. The results indicated the feasibility of reducing the specific speed by approximately 33% in this way. Figures 4; references: 7 Russian.
[266-2415]

NAVIGATION AND GUIDANCE SYSTEMS

EXPERIMENTAL SATELLITE SYSTEM FOR DETERMINING COORDINATES OF MARITIME DISTRESS

BRONITSKIY, I. S.

[Abstract] The international KOSPAS-SARSAT system is being developed jointly by the Soviet Union, the United States, Canada and France for locating maritime distress at sea or in the air. The basic tasks in the experimental stage of the project are to demonstrate the technical feasibility of detecting distress, to establish the mode of interaction of such a system with national search and rescue operations, and to establish guidelines for pilot operation of the experimental prototype. While the three Western countries are building the SARSAT (Search and Rescue Satellite Aided Tracking) part of the system, the Soviet Union is building the KOSPAS (Kosmicheskaya Sistema Poiska Avaryinykh Sudov in Samoletov = Space System for Search of Distressed Ships and Aircraft). Both parts are designed to function either separately or jointly. KOSPAS includes existing automatic distress-signal transmitters operated by the mobile Air Guard at 121.5/243 MHz and emergency radio buoys operated by the mobile Maritime Guard at 406.025 MHz ± 1.2 kHz, all capable of communicating over low-orbit satellites, as well as shipboard and coastal receiver and data processing stations. Distress signals are amplified and detected, after frequency conversion, in real time. The new ARB-406 emergency radio buoys have been designed with high precision for operation with "Kosmos 1383" and Kosmos 1447" satellites orbiting respectively at 1004-1041 km and 975-1025 km altitudes. The format of messages transmoitted by these buoys is laid out for joint KOSPAS-SARSAT operation, with 112 bits for "short" messages and 32 extra bits available for "long" ones. This experimental system, if proven successful, will be used for equipping some ships and aircraft with its satellite communication components. It will also serve as model for equipping not only large vessels but also smaller ones down to fishing boats and yachts. Figures 3; tables 2; references 3: 1 Russian, 2 Western. [266-2415]

HYDROACOUSTIC NAVIGATION DEVICES ON UNDERSEA VEHICLES

SMIRNOV, G. Ye. and TOLSTYAKOVA, N. A. [deceased]

[Abstract] Safe navigation of undersea vehicles depends largely on a survey
of the sea bed prior to and during submersion. This can be done from a
floating guard ship with a long-base sonar navigation system on board, using
arrays of at least three hydroacoustic beacons dropped to the bottom and
tuned to different frequencies, a hydroacoustic transceiver mounted on the
vehicle and a communication satellite providing reference signals. Process-
ing and transmission of digital data, greatly facilitated by available
microprocessors and computers, is preferable to use of analog devices such
as depth gauges and course indicators. A digital sonar navigation system,
which can be short-based, is suitable for manned towing vehicles as well as
for automatic exploration vehicles, the latter requiring additional controls
for maneuvering and photographing. While television serves as excellent
medium for transmission of operative and scientific data from an automatic
undersea vehicle to the guard ship, telephone is an adequate communication
link with a manned undersea vehicle. Figures 5; references 12: 4 Russian,
8 Western.
[266-2415]

PNEUMATIC DRAFT GAUGE FOR HYDROFOIL SHIPS

LUKASHEVSKIY, V. A., EL'KIND, L. B. and IVANOV, V. N.

[Abstract] A pneumatic draft gauge for hydrofoil ships combines high accur-
acy and stability with structural simplicity and corrosion resistance of
its sensing element, features not always attainable in hydrostatic or con-
tact devices and in various altimeters used for this application. The
instrument consists of an air tube with a vertical segment between a
horizontal one immersed in water and a horizontal one above the water
connected to the air supply through a throttle and a manometer. Any
element of the ship's hydrofoil can serve as fairing for the immersed
part of the tube. During motion of the ship there forms a pocket in
the water behind the orifice of the tube and air flows into it through
that tube. Calibration for reading the vertical coordinate of the hydro-
foil is based on the corresponding aerohydrodynamic relations, with
correction for loss of pressure head depending on tube and throttle
dimensions as well as on the absolute temperature. An appropriately
more elaborate version of such a pneumatic draft gauge with a 0-4 m range

has been installed on the "Tayfun" air-turbine maritime passenger ship.
Here the pressure of air entering the tube from the turbine rises from
0.3 to 0.56 MPa as the turbine speed increases, while the air temperature
varies within the 150-200°C range. The air pressure at the throttle
inlet is stabilized by means of a pressure regulator using filtered
and cooled air, which is necessary for stabilizing the air velocity
at 30 m/s and correspondingly the mass flow rate of air through the tube.
Figures 2; references: 2 Russian.
[266-2415]

HIGH-RELIABILITY INCLINOGRAPH

DEDUKHOV, V. B. and NOVOSEL'TSEV, M. I.

[Abstract] The inclinograph recommended by the USSR Register for recording
bank angles was recently modified at the Nikolayev Institute of Shipbuilding
for higher sensitivity and reliability. It now has a single scale that
covers large angles, eliminating of the scale changing mechanism which
simplifies the kinematics and reduces the scale setting error. Friction
was decreased by insertion of thin pins, easily replaceable when worn,
into the hinge joints. Friction was also decreased in the pen assembly,
by regulation of the clamping pressure and by maintenance of the parallelism
of shafts in the kinematic linkage mounted on the pendulum. The instrument
is mounted on three legs, two of them adjustable with lock nuts. Its
sensitivity is now at least 18 mm/ang/deg. and its recording speed is
50-60 mm/min, with the drum rotating uniformly to within 5%. The maximum
error is now 3%. Figures 1; tables 1.
[266-2415]

COMPARING DETECTION CAPABILITIES OF SHIP RADARS

FRIDMAN, V. Ts. and POLOVODOV, A. S.

[Abstract] Three ship radars were compared with respect to the real attain-
able energy characteristic of the instrumentation, rather the maximum range
for standard "point" targets, which depends also on unstable target param-
eters and atmospheric conditions. This energy characteristic is a function

of wavelength, transmitter output power, antenna gain, lobe width, duration
of probing or reflected pulse signal, pulse repetition rate, receiver band-
width, receiver noise factor, and scanning speed. It is also only a
small fraction of the ideal attainable energy characteristic. The three
radars were "Kivach" (USSR) and FR-701 (Furuno Co., Japan) for small
ships operating at 3.2 cm wavelength and "Prora" (Selenia Co., Italy)
for large ships operating at 3.2 or 9.8 cm wavelength. Values of the
calculated energy characteristic were 167.28 dB, 167.15 dB, 183.60 db and
190.57 dB, respectively. Figures 2; tables 1; references 3: 2 Russian,
1 Western (in Russian translation).
[266-2415]

NEW STAGE IN DEVELOPMENT OF AUTOMATIC SYSTEMS FOR AVOIDANCE OF SHIP COLLISIONS

GEORGIZON, Ye. B., YAVORSKIY, G. I. and YALOVENKO, V. Ya.

[Abstract] Ship control during collision emergencies was found to be incom-
plete, insofar as the problem of simultaneously controlling the ship's posi-
tion and avoiding collision with another ship has not yet been adequately
solved. It still requires the presence of the pilot simultaneously in two
places: chart house and lookout cabin. The next step therefore is
to integrate both facilities through appropriate layout of navigation
and data transmission equipment. The most promising scheme is insertion
of a buffer register between the radar (acting as a source of video
signals carrying information about the ships' coordinates) and the data
processing system. The latter consists of a coordinates converter,
indicator, computer, and memories in a loop. The buffer register discretizes
the video signals before recording them in a memory ahead of the indicator.
There is another memory between indicator and computer. A probing pulse
of 0.10 μs duration requires a buffer register of up to 1 kbit capacity
and a 2-3 Mbit matrix memory between register and indicator, with all
components capable of operating at a speed equivalent to 40-50 MHz.
Automatic tracking of radar references can be aided by or replaced by
satellite observations or radio navigation with precise reading between
observations. Figures 1.
[266-2415]

FLUID MECHANICS

UDC 532.551-3:621.224

ON VORTEX TRANSPORT IN TURBINE CHANNELS

BYKOV, A. A., Institute of Problems of Machine Building, UkSSR Academy
of Sciences, Khar'kov

[Abstract] The system of equations of motion and continuity describing the
steady-state vortex flow of a nonviscous incompressible fluid represents a
quite difficult problem as regards the construction of a numerical method
of solution and the application of physical boundary conditions. Such a
system, written in terms of the velocity vector, pressure, density and total
energy, can be written so that the equations correspond to the classical
problem of finding a velocity field from a specified divergence and vortex
field, which can then be solved by various methods, in particular, the
method of integral equations. The vortex transport equation is algebraic
with respect to the velocity vector fields and can be used to determine the
vortex field in a turbine channel by means of an iterative technique with
the appropriate boundary conditions. The distribution of the current func-
tions is assumed to be known and the total energy at any point in the channel
is defined by a given function. A unique feature of this analytical solution
is the use of a family of current surfaces for the coordinate system. The
efficiency of this approach to the determination of the vortex field
throughout the entire internal region of a channel, which yields a unique
solution, is due to the fact that the labor involved in setting up the
current surface system of coordinates is payed back to a considerable
extent by having an analytical function which defines the vortex field
everywhere in the region. The purely theoretical treatment adduces no sample
calculations or applications. References 6: 5 Russian; 1 Western in Russian
translation.
[174-8225]

TURBULENT JET FLOW IN A CHANNEL WITH A CIRCULATION REGION

GLEBOV, G. A. and PETROV, V. N.

[Abstract] The calculation of the flows formed with the interaction of a
turbulent flow and a slipstream in a channel is best done using approxima-
tion techniques. The following assumptions are made in this analysis of
the problem: the composition of the gas and the temperature of the flow
and slipstream are the same; heat exchange and wall friction in the
channel are disregarded; the static pressure in the channel cross-section
is constant; the walls have little effect on the internal mixing layer
boundary. The flow field is broken down into three regions: a region
of the flow in which the directions of the axial velocities of the central
flow and slipstream coincide; a region of reverse flow; a region of
wake type flow development. The reverse flow region can in turn be
broken down into subregions separated by a point corresponding to the
boundary of the stream reaching the channel wall. This point is the
center of the circulation zone. The velocity profile in the mixing
layer is found by a polynomial approximation of the profile of the Reynolds
shear stresses in the channel cross-section. Integral momentum and
mass rate of flow equations are used to find the flow parameters. A
comparison of computed and experimental data shows that this approximation
is an adequately precise description of the major properties of this
flow. The computer and experimental changes in the dimensions of the
reverse flow region are plotted graphically as a function of the ratio
of the central flow and slipstream velocities in a channel where the
ratio of the mixing layer to channel radii is 0.533, showing good agreement.
Figures 2; references: 3 Russian.
[165-8225]

ON LIMITS OF APPLICABILITY OF LINEAR MODELS TO DYNAMICS OF GAS CHANNELS IN
AIRCRAFT ENGINES

BAYKOV, A. V.

[Abstract] The analysis of the dynamics of gas channels in aircraft engines
is usually based on the equations of gas dynamics in a linear approximation.
The various linearizations of the initial equations described in the litera-
ture are sometimes contradictory. One designer takes viscous friction into

account and disregards gas motion through the cylindrical channel, while another does just the opposite. Additionally, a linear approximation requires the determination of its range of applicability. This paper uses an approach to the study of nonlinear oscillations based on an analysis of Burgers equation from nonlinear acoustics which permits precise solutions in order to ascertain the effect of various factors on the propagation of finite amplitude oscillations in engine channels. A simple diagram plotting a coefficient which accounts for gas motion through the channel as a function of a factor describing the attenuation of oscillations in the system is used to illustrate the areas of applicability of various linear models. The diagrams show the areas where convective transport, frictional resistance, gas motion in the channel, gas flow oscillation amplitude or nonlinear effects must be considered or can be disregarded. Figures 3; references: 5 Russian.
[165-8225]

LONG RANGE EFFECT OF TURBULENT PRESSURE PULSATIONS IN PLANE-PARALLEL FLOWS AT DIFFERENT VELOCITIES WITH VARIOUS FLAME FRONTS

ABRAMOVICH, G. N. and RUTOVSKIY, V. B.

[Abstract] Large vortices are produced in turbulent flows with the interaction of the pulsating and averaged velocity fields. These vortices influence the flow in regions relatively distant from them. This paper formulates and experimentally demonstrates a technique of calculating the levels of turbulent velocity and pressure pulsations in a diffusion flare both with and without a slipstream in the flow. The analytical expressions are derived from a plane model in which the vortices are replaced by rotating cylinders having axes perpendicular to the flow and radii proportional to an integral turbulence scale; the flow originates from two planar nozzles of substantially different size. The resulting formulas for these pulsations and the estimate of the increase or decrease in the turbulence in the presence of a flame front are in good agreement with test data from stands which are illustrated and described. Pressure pulsations are independent of the density distribution at a nozzle section, while this density is the critical factor in determining the pulsation velocity field. When the nozzles are sufficiently close together, two velocity pulsation maxima are to be expected and their position can be computed beforehand. Sample calculations are also performed for the case when the distance to the boundary of the second nozzle is small and both streams merge rapidly into a common flow, as is frequently the case with turbojet engines. Figures 8; references 5: 4 Russian; 1 Russian in English translation.
[165-8225]

MECHANICS OF SOLIDS

ANTIFRICTION NICKEL-PHOSPHOROUS COATINGS ON ALUMINUM ALLOY PRODUCTS

LATATUYEV, V. I., candidate of technical sciences and GANAY, G. N., engineer

[Abstract] A nickel-phosphorous coating having a hardness of up to
900-1,200 kg/mm^2 following heat treatment and an adhesion which depends on
the processing of the aluminum alloy surface is quite promising for chemical
application on the surfaces of aluminum based friction pairs which otherwise
exhibit poor hardness and rapid wear. Such coatings have improved anti-
friction properties at phosphorous contents of from 2 to 15%. The following
surface treatment procedure has been approved for use at the Transportation
Machine Building Plant imeni Lenin in Barnaul: The aluminum surface is de-
greased in an organic solvent, etched in a 10% NaOH solution and then flushed
with water after a maximum of 70 seconds. The surface is neutralized with
concentrated nitric acid for 5 to 7 seconds, flushed with water again and
exposed to contact application of the nickel in a solution of nickel sulfate,
ammonium or sodium fluoride and HCl. After flushing with a nickel and sodium
salt and acid solution, a tight nickel-phosphorous coating is formed with
good adhesion to the aluminum substrate. The adhesion and hardness are en-
hanced considerably following heat treatment for two hours at 230 ± 10°C.
[194-8225]

DETERMINATION OF BLADE SERVICE LIFE UNDER IRREGULAR LOADING CONDITIONS

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[Abstract] The following procedure can be used to determine the service life
of turbine blading subject to irregular varying loads: 1) The distribution
of the dynamic stresses is found at resonance. In the simplest case, they

depend on how well the values of the coefficient of load nonuniformity are known. 2) The fatigue characteristics of the vane blade and root are determined for the case of asymmetrical loading during the design stage based on data from fatigue tests of samples during a symmetrical loading cycle. A coefficient of asymmetry is found for the specified tensile stresses due to centrifugal forces and static bending stresses. 3) The ultimate load coefficient is plotted as a function of the number of load units until a fatigue crack appears with different ratios of the maximum to steady-state stress amplitudes. 4) The probability of the occurrence of a fatigue crack for the specified operational loading and fatigue parameters of the blading is then determined. This procedure is illustrated with the calculation of the distribution function of the service life of the vane blades of a turbine for a feed pump. The blade length is 152 mm, the working speed is 4,720 - 5,800 r.p.m. and the resonant frequency of the axial oscillations averaged for the blading is 730 Hz. The 12x13Sh steel vanes have a fatigue limit of smooth samples of 390.8 MPa for a symmetrical load cycle. The distribution functions of the service life are plotted graphically, illustrating the probability of a fatigue failure by the selected service lifetime for different variants of the average maximum stresses. The probability of a fatigue crack in the blade of this stage does not exceed 0.15% when the average value of the maximum stresses is one-half the ultimate stress amplitude for the specified load cycle asymmetry. By knowing the operational loading of the blading and the fatigue parameters, the probability of blade failure can be determined for any specified turbine service life. Figures 3; references 12: 10 Russian; 2 Western.
[170-8225]

ON SOLVING NONLINEAR PROBLEMS OF AIRCRAFT STRUCTURAL MECHANICAL DESIGN

CHERNIKOV, S. K.

[Abstract] The determination of the stress deformed state of a structure represented by a nonlinear model frequently entails writing equations that have no precise solutions which can be readily found. Nonlinear algebraic equations are usually employed in this case and are solved by such methods as finite differences, finite sums, etc. The problem is thus one of finding the roots of a nonlinear system. The most acceptable methods are those based on the extrapolation of the solution with respect to a parameter. The major drawback to these techniques is the sensitivity to singularities in the system, which necessitates a considerable reduction in the iteration step, thereby reducing the algorithmic efficiency, increasing the computing time and introducing a certain element of ambiguity which depends on the a priori

knowledge of the properties of the initial system of equations. Parameter continuation algorithms are free of these deficiencies. This paper is a theoretical analysis of two formal approaches to the construction of such algorithms for problems of aircraft structural design which involve geometric or physical nonlinearity of a structure, or nonlinearity of the mechanical boundary conditions, thermophysical properties of the materials, etc. The purely theoretical treatment adduces no sample calculations or illustrations of applications. Figures 2; references: 5 Russian. [165-8225]

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